Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1. (Original) A method for dividing an image region of a color image according to colors, comprising the steps of:

(a) setting a plurality of representative colors;

(b) calculating plural angle indices for each pixel color in the color image, the plural angle indices for a pixel color representing angles between an individual color vector of the pixel color and representative color vectors of the plurality of representative color vectors in a predetermined color space of at least two dimensions;

(c) calculating plural distance indices for each pixel color in the color image, the plural distance indices for a pixel color representing distances between the pixel color and the plural representative colors in the color space;

(d) calculating plural composite distance indices for each pixel color in the color image based on the distance indices and the angle indices, the plural composite distance indices being associated with the plurality of representative colors, respectively; and

(e) classifying pixels in the color image into plural representative color regions associated with the plural representative colors, according to the composite distance indices, thereby dividing the image region of the color image into the plural representative color regions.

2. (Original) A method in accordance with claim 1, wherein each composite distance index includes a sum of an angle index and a corresponding distance index.

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3. (Original) A method in accordance with claim 1, wherein each composite distance index includes a product of an angle index and a corresponding distance index.

4. (Original) A method in accordance with claim 1, wherein the step (e) includes the step of assigning each pixel to one of the plural representative color regions that gives a minimum value of the composite distance indices.

5. (Original) A method for dividing an image region of a color image according to colors, comprising the steps of:

(a) setting a plurality of representative colors;

(b) calculating plural angle indices for each arbitrary individual color in the color space, the angle indices for an arbitrary individual color representing angles between an individual color vector of the arbitrary individual color and representative color vectors of the plurality of representative colors in a predetermined color space of at least two dimensions;

(c) calculating distance indices for each arbitrary individual color in the color space, the distance indices for an arbitrary individual color representing distances between the arbitrary individual color and the plural representative colors in the color space;

(d) calculating composite distance indices for each arbitrary individual color in the color space based on the distance indices and the angle indices, the plural composite distance indices being associated with the plurality of representative colors, respectively;

(e) relating each arbitrary individual color in the color space with one of the plural representative colors according to the composite distance indices, and preparing a lookup table

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storing the correspondence between each arbitrary individual color and the plural representative colors; and

(f) classifying pixels in the color image into plural representative color regions associated with the plural representative colors, with the aid of the lookup table, thereby dividing the image region of the color image into the plural representative color regions.

6. (Original)   A method in accordance with claim 5, wherein each composite distance index includes a sum of an angle index and a corresponding distance index.

7. (Original)   A method in accordance with claim 5, wherein each composite distance. index includes a product of an angle index and a corresponding distance index.

8. (Original)   A method in accordance with claim 5, wherein the step (e) includes the step of relating each arbitrary individual color to one of the plural representative colors that gives a minimum value of the composite distance indices.

9. (Original)   An apparatus for dividing an image region of a color image according to colors, comprising:

a representative color setter configured to set a plurality of representative colors;

an angle index calculator configured to calculate plural angle indices for each pixel color in the color image, the plural angle indices for a pixel color representing angles between an individual color vector of the pixel color and representative color vectors of the plurality of representative colors in a predetermined color space of at least two dimensions;

a distance index calculator configured to calculate plural distance indices for each pixel color in the color image, the plural distance indices for a pixel color representing distances between the pixel color and the plural representative colors in the color space;

a composite distance processor configured to calculate plural composite distance indices for each pixel color in the color image based on the distance indices and the angle indices, the plural composite distance indices being associated with the plurality of representative colors, respectively; and

a color region divider configured to classify pixels in the color image into plural representative color regions associated with the plural representative colors according to the composite distance indices, thereby dividing the image region of the color image into the plural representative color regions.

10. (Original) An apparatus in accordance with claim 9, wherein each composite distance index includes a sum of an angle index and a corresponding distance index.

11. (Original) An apparatus in accordance with claim 9, wherein each composite distance index includes a product of an angle index and a corresponding distance index.

12. (Original) An apparatus in accordance with claim 9, wherein the color region divider assigns each pixel to one of the plural representative color regions that gives a minimum value of the composite distance indices.

13. (Cancelled)

14. (Original) A method for inspecting a circuit board, comprising the steps of:

(a) capturing a color image of the circuit board;

(b) setting a plurality of representative colors;

(c) calculating plural angle indices for each pixel color in the color image, the plural angle indices for a pixel color representing angles between an individual color vector of the pixel color and representative color vectors of the plurality of representative color vectors in a predetermined color space of at least two dimensions;

(d) calculating plural distance indices for each pixel color in the color image, the plural distance indices for a pixel color representing distances between the pixel color and the plural representative colors in the color space;

(e) calculating plural composite distance indices for each pixel color in the color image based on the distance indices and the angle indices, the plural composite distance indices being associated with the plurality of representative colors, respectively;

(f) classifying pixels in the color image into plural representative color regions associated with the plural representative colors, according to the composite distance indices, thereby dividing an image region of the color image into the plural representative color regions; and

(g) performing inspection of the circuit board using at least one of the divided plural representative color regions.

15. (Original) A method in accordance with claim 14, wherein each composite distance index includes a sum of an angle index and a corresponding distance index.

16. (Original) A method in accordance with claim 14, wherein each composite distance index includes a product of an angle index and a corresponding distance index.

17. (Original) A method in accordance with claim 14, wherein the step (f) includes the step of assigning each pixel to one of the plural representative color regions that gives a minimum value of the composite distance indices.

18. (Original) A method for inspecting a circuit board, comprising the steps of:

(a) setting a plurality of representative colors;

(b) calculating plural angle indices for each arbitrary individual color in the color space, the angle indices for an arbitrary individual color representing angles between an individual color vector of the arbitrary individual color and representative color vectors of the plurality of representative colors in a predetermined color space of at least two dimensions;

(c) calculating distance indices for each arbitrary individual color in the color space, the distance indices for an arbitrary individual color representing distances between the arbitrary individual color and the plural representative colors in the color space;

(d) calculating composite distance indices for each arbitrary individual color in the color space based on the distance indices and the angle indices, the plural composite distance indices being associated with the plurality of representative colors, respectively;

(e) relating each arbitrary individual color in the color space with one of the plural representative colors according to the composite distance indices, and preparing a lookup table storing the correspondence between each arbitrary individual color and the plural representative colors;

(f) capturing a color image of the circuit board;

(g) classifying pixels in the color image into plural representative color regions associated with the plural representative colors, with the aid of the lookup table, thereby dividing an image region of the color image into the plural representative color regions; and

(h) performing inspection of the circuit board using at least one of the divided plural representative color regions.

19. (Original) A method in accordance with claim 18, wherein each composite distance index includes a sum of an angle index and a corresponding distance index.

20. (Original) A method in accordance with claim 18, wherein each composite distance index includes a product of an angle index and a corresponding distance index.

21. (Original) A method in accordance with claim 18, wherein the step (e) includes the step of relating each arbitrary individual color to one of the plural representative colors that gives a minimum value of the composite distance indices.

22. (Withdrawn)   An apparatus for inspecting a circuit board, comprising:

a camera unit configured to capture a color image of the circuit board;

a representative color setter configured to set a plurality of representative colors;

an angle index calculator configured to calculate plural angle indices for each pixel color in the color image, the plural angle indices for a pixel color representing angles between an

individual color vector of the pixel color and representative color vectors of the plurality of representative colors in a predetermined color space of at least two dimensions;

a distance index calculator configured to calculate plural distance indices for each pixel color in the color image, the plural distance indices for a pixel color representing distances between the pixel color and the plural representative colors in the color space;

a composite distance processor configured to calculate plural composite distance indices for each pixel color in the color image based on the distance indices and the angle indices, the plural composite distance indices being associated with the plurality of representative colors, respectively;

a color region divider configured to classify pixels in the color image into plural representative color regions associated with the plural representative colors according to the composite distance indices, thereby dividing an image region of the color image into the plural representative color regions; and

an inspection unit configured to perform inspection of the circuit board using at least one of the divided plural representative color regions.

23. (Withdrawn)   An apparatus in accordance with claim 22, wherein each composite distance index includes a sum of an angle index and a corresponding distance index.

24. (Withdrawn)   An apparatus in accordance with claim 22, wherein each composite distance index includes a product of an angle index and a corresponding distance index.

25. (Withdrawn)   An apparatus in accordance with claim 22, wherein the color region divider assigns each pixel to one of the plural representative color regions that gives a minimum value of the composite distance indices.

26. (Withdrawn)   An apparatus for inspecting a circuit board, comprising:

a camera unit configured to capture a color image of the circuit board;

a lookup table that has an arbitrary individual color as input and a color number indicating one among plural representative colors as output; and

a color region divider configured to obtain a representative color number for each pixel color in the color image with the aid of the lookup table, and to classify each pixel in the color image into one of plural representative color regions associated with the plural representative colors according to the representative color numbers, thereby dividing an image region of the color image into the plural representative color regions; and

an inspection unit configured to perform inspection of the circuit board using at least one of the divided plural representative color regions.